

A FORMAL APPROACH TO RESEARCH COLLABORATION AND KNOWLEDGE SHARING

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ABSTRACT

Queensland Department of Main Roads (QDMR) and ARRB Group (ARRB) have a long history of successfully working together to meet the engineering and technology challenges of building and managing the Queensland road network. In August 2007, ARRB signed a multi-million dollar agreement with QDMR to provide research expertise and facilitate knowledge sharing between the two organisations. The Agreement was the first of its type in Australia. A major aim of the Agreement is to secure in-house specialist capabilities in both organisations over the longer term.

The desired outcome of the Agreement is to improve the specialist capability and capacity of QDMR and ARRB through a sustained, collaborative program of challenging projects which deliver superior technology and road and transport solutions for the people of Queensland. The focus of the technical issues being addressed under the Agreement includes: road safety, pavements and materials, structures, traffic engineering including ITS, asset management, transport and traffic management, transport economics, project management and environmental management.

This paper presents details of the Agreement, including underlying principles and objectives and key performance indicators, and a summary of the activities conducted since the Agreement commenced. Details of some of the projects conducted under the Agreement are also presented.

1. INTRODUCTION

Queensland Department of Main Roads (QDMR) and ARRB Group (ARRB) have a long history of successfully working together to apply sound engineering and technology to the challenges of building and managing the very diverse Queensland road network.

QDMR is currently experiencing a dramatic growth in the number of infrastructure projects it is managing and it is forecast that this level of activity will be at least maintained over the next decade.

ARRB's business is growing rapidly, with high demand for skills and expertise across the road sector both within Australia and overseas. The focus of available resources and development of new, sustained skills in areas that meet the needs of the State Road Authorities (ARRB's owners) is a priority. This will ensure the efficient and effective management of Australia's road network now and into the future.

Most State Road Authorities, and ARRB, are facing challenges related to the loss of technical expertise, including retirements and industry competition for engineering and related skills from the mining and resources sector and increased global infrastructure delivery programs.

Austroads recognised the need to rebuild technical capability and capacity within the roads sector, and the need to encourage ARRB to develop capability and capacity, with the development of the Austroads Technical Research program, which commenced in 2004/2005. This program addresses strategic issues at the national level which have different levels of relevance to the individual States. Austroads is also sponsoring the 'Professional Development for Road Engineering' project, the aim of which is to work with universities and industry to develop a curriculum that caters specifically for employees of the road engineering sector.

In August 2007, ARRB Group (ARRB) signed a multi-million dollar agreement with Queensland Department of Main Roads (QDMR) to provide research expertise and knowledge sharing between the two organisations. The Agreement was the first of its type in Australia.

This paper presents details of the Agreement, including underlying principles and objectives and key performance indicators, and a summary of the activities conducted during the first year of the Agreement. Brief details of some of the projects conducted under the Agreement are also presented.

2. DETAILS OF THE AGREEMENT

1.1 Purpose of the Agreement

The purpose of the Agreement is to:

improve the specialist capability and capacity of QDMR and ARRB through a sustained, collaborative program of challenging projects which deliver superior technology and road and transport solutions for the people of Queensland.

In fulfilling this purpose, QDMR and ARRB recognise and acknowledge that:

- the Agreement can only be successful if there is a strong level of trust; the building of a trustful environment is a fundamental tenet of the Agreement; open and honest communication between all parties is essential
- the Agreement is not only concerned with the delivery of projects but also the building of specialist capability, capacity and the sharing of knowledge in both organisations
- the most successful outcomes will be achieved if the impact of the Agreement on both parties is similar, i.e. win/win or lose/lose, but not win/lose
- access to, and contributions by, the most appropriate personnel is essential for best outcomes
- total support at all levels within both parties is assumed
- outputs and outcomes must be in line with community expectations
- efficient delivery mechanisms must be adopted which preclude duplication of effort
- the parties to this Agreement acknowledge that it is not legally binding.

1.2 Output Objectives

The Agreement will seek to achieve the following output objectives:

- achieve greater certainty in the delivery of QDMR corporate projects (R&D, technical knowledge management, capability) and operational projects
- enhance the reputation of the ARRB Queensland office, and its support staff throughout Australia, as the leading provider of high-level technical advice and training to QDMR
- harness the latest developments from research, technology and best practice of relevance to Queensland
- secure in-house specialist capabilities in both organisations over the long term
- enhance the profile of QDMR and ARRB staff within Queensland and nationally.

1.3 Activities Addressed Under the Agreement

The Agreement is flexible and covers almost any form of support to QDMR initiatives. However, as formulated, the following activities were envisaged:

- provision of ad hoc advice
- R&D projects across multiple technologies
- peer reviews
- the development and application of specialist software
- consulting in all of the technical issues of relevance to QDMR and where ARRB has the expertise
- the development of guidelines and specifications
- the provision of pavement condition data and equipment to collect that data
- the development and delivery of 'just-in-time' training
- secondments to specialist areas within both ARRB and QDMR.

The focus of the technical issues to be addressed under the Agreement includes: road safety, pavements and materials, structures, traffic engineering including ITS, asset management, transport and traffic management, transport economics, project management and environmental management.

1.4 Key Performance Indicators

The Key Performance Indicators (KPIs), and the measures for assessing them, were agreed. They are shown in Table 1.

Table 1: Key Performance Indicators

Key Performance Indicator	Measure
Strength of the Agreement	High degree of cooperation between the partners to the Agreement
Achieve greater certainty in the delivery of QDMR corporate and operational projects	100% of agreed corporate projects procured
Achieve increased capacity to complete projects in Qld and enhanced reputation of ARRB Qld Office	<ul style="list-style-type: none">• Continued growth in scope and value of the Agreement• Increased expertise and staff capacity in Queensland
Harness the latest developments from research, technology and best practice of relevance to Queensland	Accelerated the delivery of key studies and documentation through access to appropriate skills and expertise
Secure in-house specialist capabilities in both organisations over the long term	A major proportion of the program has been partially or totally focussed on capability improvement

1.5 Funding of the Agreement

The initial agreement covers the period from 2007/2008 to 2012/2013. In 2007-2008 a procurement value of \$2 million was proposed which was targeted to grow to \$4 million in expert advice and services by 2012-2013. These minimum target values ensure ARRB:

- retains a proportion of its core expertise for QTMR use
- provide a bulk purchasing discount
- provides additional opportunities for resource and knowledge sharing and capacity building initiatives.

Projects will be funded through a range of mechanisms available to QDMR and ARRB, for example:

- various Directorates within QDMR
- Roads Implementation Program (RIP) projects
- Regions/Districts, either as individual entities or joint ventures
- various opportunities for special grant initiatives available from sources such as the Commonwealth Government, AusAid and the World Bank. Where appropriate, ARRB will assist in procuring this funding.

2 MANAGEMENT OF THE AGREEMENT

2.1 Operational Framework

The management of this Agreement requires a consistent approach to ensure that QDMR project managers and senior management receive a professional, reliable and technically sound service that is also all consistently costed.

The Agreement allows for simplified engagement of ARRB by QDMR. Typically, proposals can be initiated with a single-page scope statement produced by ARRB following a request from QDMR. If necessary, longer scoping statements can be prepared to ensure the activity and deliverables are fully understood.

Generally ARRB's Queensland office is responsible for developing initial contact with staff in QDMR and gathering details on potential projects. In those cases, ARRB's Queensland office is responsible for identifying appropriate ARRB staff to lead and work on projects and facilitate contact with QDMR staff.

ARRB Project Leaders (managers) are drawn from all Divisions within ARRB and from all offices (Brisbane, Sydney, Melbourne, Perth, Adelaide, Dubai) to ensure that the best possible advice is provided.

The Agreement is managed by an Agreement Board consisting of senior staff of both ARRB and QDMR, with the routine administration managed by Agreement Managers. Project teams are set up to deliver individual projects and a Team Leader is appointed to lead the project. Training needs, and the management of ad hoc advice, are also addressed.

2.2 Project Management

The efficient delivery of projects is a fundamental KPI of the success, or otherwise, of the Agreement. A project management system has been developed to assist in the achievement of the KPIs. The project management system is detailed enough to ensure that the aims of the project, and the timelines and deliverables, are clear without being so complex that valuable resources are wasted in over-administration.

2.3 Review and Evaluation of Operation of Agreement

If the Agreement is to be viable then its performance must be effectively reviewed on a regular basis. The Agreement Managers evaluate achievements and related objectives over the previous reporting period and report to the Board. The review is conducted in accordance with an agreed and

documented process. The Agreement Managers also review any benefits deriving from completed projects on a regular basis.

2.3.1 Monthly Health Checks

A 'health check' is produced by ARRB at the end of each month and distributed to the Agreement Board. A typical 'health check' includes the following information:

- a review of the KPIs and actions taken
- progress of projects, including:
 - funding target and progress of projects sold to QDMR
 - program delivery
- current and future opportunities, including capacity building and knowledge transfer opportunities.

If relevant, details of new projects procured during the month, and imminent initiatives, may also be included.

3 REVIEW OF KPIs

A review of the progress with the KPIs follows. QDMR Project Leaders are shortly to be surveyed to score ARRB's performance from 1 to 5, where 1 represents poor performance and 5 represents excellent performance.

3.1 Strength of the Agreement

The measure for this KPI is the degree of cooperation between QDMR and ARRB.

Both parties have agreed that there is a high degree of cooperation between the partners to the Agreement. The establishment of the Agreement Board, and monthly meetings, have ensured a free flow of information. The recent addition of a QDMR member representing the Regions better reflects the clients base.

3.2 Delivery of QDMR Corporate and Operational Projects

The measure for this KPI is the percentage of agreed corporate projects procured. The targets set for 2007 / 2008 were achieved with just over \$2 million worth of work sold. In terms of 2008 / 2009 almost 70% of the target funding of \$2.2 million has been sold by March 2009.

This agreement has also provided increased certainty in the delivery of key QDMR projects with 100% of procured projects delivered to agreed timeframes and budgets.

3.3 Increased Capacity and Enhanced Reputation of ARRB Qld Office

The measure for this KPI is the continued growth in scope and value of the Agreement.

Since the Agreement was signed, the capacity of the ARRB Queensland office has grown: eight new full-time staff, three replacement full-time positions and five casual staff have been employed over the past two years. In addition, significant additional focus from ARRB staff has been given to QDMR projects.

ARRB has placed a great deal of emphasis on the appointment of staff who service the traditional areas of QDMR's business (surfacing, asset management, etc.) but who are based in the Queensland office. For example, nine of the ten jobs procured from the Regions in 2007/2008 were, or are being, managed by staff from the ARRB Queensland office.

The increased services being provided to the Regions, and the increased bids for allocated resources in 2008/2009, suggest that the enhanced relationship between ARRB and the Regions is perhaps the most significant achievement.

3.4 Harness Latest Developments from Research, Technology and Best Practice

The measure for this KPI is the notable improvement in skills of QDMR staff, and QDMR documentation, arising from joint projects.

Whilst the Agreement is only in its early stages, it is significant that a number of projects have addressed the need to revise current QDMR documentation whilst other projects are addressing emerging issues. Examples include:

- draft QDMR Sprayed Sealing Manual
- merging of QDMR Specifications
- Accelerated Road Rehabilitation Project
- environmental and cultural heritage audit framework
- climate change framework.

A major initiative commenced in 2007/2008 under the Agreement was the need to assist Element Managers in the management of the various elements. Details of the road system management framework involving condition monitoring and investment prioritization for some 34 road asset 'elements' can be found in Robertson [1]. The first project was a scoping study examining the role that risk assessment may play in the management of the elements, initially the road safety elements.

Whilst some specific knowledge transfer activities were conducted, initial emphasis was placed on educating both QDMR and ARRB staff about the Agreement and discussions directed at identifying immediate needs. This was seen as being particularly important if projects were to be specifically earmarked for conduct under the Agreement in 2008/2009. Nevertheless, during 2008, 53 QDMR staff attended five ARRB workshops in Brisbane and two staff attended a workshop in Sydney. More formal lines of communication to national and international research have also been engaged at an operational level.

3.5 Secure In-House Specialist Capability in Both Organisations

The measure for this KPI is that a major proportion of the program has been partially or totally focussed on capability improvement.

As a direct result of the Agreement, to date ARRB has secured additional expertise in its Brisbane office to meet road safety, pavement performance, asset management and transport economics needs from the department. This is in addition to the additional capacity brought in to Queensland from the other ARRB offices.

A measure to demonstrate a commitment to skills development across both organisations will be developed and assessed by the Agreement Board quarterly. This KPI is seen as a longer-term strategy. In addition to this it is planned that secondment opportunities will be provided to staff as future capability development initiatives.

4 SUMMARY OF SELECTED PROJECTS CONDUCTED UNDER THE AGREEMENT

4.1 NetRisk Statewide Contract

QDMR engaged ARRB to undertake a strategic road safety analysis of all 32,000 km of state-controlled roads in Queensland, using the jointly owned NetRisk – Road Network Safety Assessment Tool. This strategic assessment provides a proactive road safety analysis of the inherent road safety risk on all road sections, based on extensive research undertaken by the ARRB Group Ltd.

When combined with crash analysis results the department is now able to better consider road safety needs and priorities at a road network level and target available funding to meet the road safety challenge.

This success of this project has seen a broader initiative undertaken to extend the analysis to the higher order local government roads across Queensland through the Roads Alliance model between QDMR and local government.

4.2 Accelerated Road Rehabilitation Program

The Queensland Government allocated \$16.2 billion to its 2008-09 to 2012-13 rolling five-year Roads Implementation Program (RIP). The aim of the RIP is to 'provide a safe and efficient road network that connects people and places'. The program aims to respond to the significant economic and population growth taking place across the State, particularly in the south-east corner.

Sound road asset management theory recognises that the 'worst first' approach to rehabilitation does not necessarily guarantee optimum performance of the network as a whole. In fact, it may result in a road authority being confronted with a scenario of a 'permanent backlog' of rehabilitation works and deterioration of parts of the network because the amount of funding available for these works was insufficient to meet demands. However, from time to time it is acknowledged that intervention will be required where network condition at specific locations has the potential to cause unsafe conditions for road users.

An alternative strategy for the more cost-effective management of the road asset is to adopt an 'accelerated pavement rehabilitation program' (ARRP). This involves the bringing-forward of scheduled works in order that the resulting benefits to the community become available much earlier than would be the case if the traditional 'worst first' strategy was adopted. These benefits can include safety improvements, savings in vehicle operating and other user costs, and improved freight efficiency.

The QDMR project examples which demonstrate the ARRP concept include:

- the rehabilitation of a highway in Central Queensland, involving approximately 71 km of road rehabilitation, strengthening and widening works and the replacement of, initially, five timber bridges at a cost of approximately \$40 million
- the replacement of 31 bridges in Southern Queensland, where construction is on-going as part of a Bridge Renewal Program (BRP) with an estimated outturn cost of approximately \$120 million.

Results of the economic analysis as part of the ARRP Stage 1 research and concept study for the Dawson Highway suggested that an ARRP approach could deliver significantly higher net economic benefits than RIP because road user benefits accruing from infrastructure improvements are brought forward under ARRP, and investment costs were less. Estimated net economic benefits were equal to approximately \$15 million and \$68 million for the 'base traffic' scenario and the 'diverted traffic' scenario, with internal rates of return (IRR) of 14.8% and 37.3% respectively based on an 'incremental' analysis comparing ARRP and RIP. These benefits were made up from savings in vehicle operating costs (VOC), travel time and reduced crashes as well as savings in agency costs.

The results of the financing analysis showed that the accelerated rehabilitation of the highway and the replacement of the bridges had advantages for Queensland. For example, the analysis suggested a healthy positive discounted net cash flow, equivalent to a saving of approximately \$13.3 million, in terms of their financing under the ARRP.

It was recommended that the ARRP concept be recognised as a more efficient approach to investing in road infrastructure and that consideration should be given to applying the ARRP concept to other infrastructure elements within QDMR's road system management framework.

The focus of Stage 2 of the project which commenced in 2008, and which aims to provide an interim post-evaluation of the two projects, comprises:

- ❑ the consolidation of the Stage 1 estimates for the highway rehabilitation taking account of as-built information and out-turn costs, and a more robust estimate of future traffic, including the potential for diversion

- ❑ full economic analysis of the BRP bridge improvement projects, including the likely impacts on travel patterns and reliability of access, and safety benefits arising from improved bridges and approach roads.

This will provide valuable input to the final post-completion evaluations of both examples once the network has been in operation for a number of years. Further details of the methodology employed is reported by Naude et al [2].

4.3 Climate Change Framework

Considerable research has been conducted at the international, national and jurisdictional level on the effects of climate change in relation to transport. This research suggests that significant changes in climate have been emerging and are expected to become more pronounced in the future. The European Environment Agency predicted in 2007 that, as a result, a wide range of impacts on the natural and man-made environment across sectors and regions are expected to lead to varying economic, social and environmental costs.

The road transport sector is a key area that not only contributes to climate change by way of greenhouse gas emissions, but also is predicted to be increasingly affected by climate change. In the short term, this will occur through events such as flooding and cyclones and, in the longer term, through the effects of increased temperatures, rising sea levels and changing precipitation distribution affecting road infrastructure and the demand for travel.

QDMR commissioned ARRB to prepare a position paper examining the possible impacts of climate change on road transport with specific reference to the Queensland context. ARRB was also asked to provide a framework that could assist QDMR in formulating an appropriate response to these changes in the future, especially in terms of how it manages its road network.

Details of this study are contained in a companion paper to this Conference [3].

4.4 Evaluation of ITS Tools for Heavy Vehicle Progression and Access on the Road Network

QDMR is currently piloting a broad range of intelligent transport system (ITS) initiatives to maximise the efficiency of both heavy vehicle and normal vehicle transport on the National highway (AusLink) infrastructure network. The following components are included in this pilot study:

- road closures for mountain range crossings and road warnings for flooding
- network access signage, i.e. signs advising drivers of current road conditions/restrictions throughout the network.

ARRB was commissioned by QDMR to conduct an independent evaluation and provide the details of the evaluation methods of these rural ITS deployments. The first report prepared for this project was the methodology report. The first part of the report reviewed overseas evaluations of rural ITS projects.

The United States Department of Transport (US DOT) developed the Advanced Rural Transportation Systems (ARTS) program to meet the needs of the agencies responsible for the operation and maintenance of rural transportation systems, as well as travellers in and through rural areas. Various ITS tools have been applied in mainstream rural highway operations including variable message signs (VMS), road weather information systems (RWIS), highway advisory radio, traffic information kiosks, the Internet and remote cameras. Similar projects have been implemented in Europe including the vehicle activated signs (VAS) in the UK and the slippery surface and headway VMS in Finland.

Key performance indicators (KPIs) that have been used in overseas evaluations of rural ITS include: safety, speed, efficiency, mobility, motorist awareness, user satisfaction, system performance, impacts on tourists and tourism, and cost.

Evaluation methods include: crash data analysis, travel time and delay surveys, before-after speed surveys, motorist surveys, internet and telephone surveys, site visits, interviews with key stakeholders and performance monitoring.

In Australia, some rural ITS projects such as flood, ice and/or fog warning systems, VAS, VMS and signal priority for heavy vehicles have been implemented in New South Wales, Victoria, South Australia and Tasmania. Rural ITS projects have also been proposed in Western Australia. Some speed survey and crash data analyses have been conducted or proposed for evaluation.

Representatives from jurisdictions around Australia and rural QDMR Regions were also consulted to assist in determining the most appropriate methods of evaluating the four rural ITS pilot projects.

The results of the literature review and stakeholder consultation indicated that the following methods and associated KPIs were appropriate for evaluating the four pilot projects of this project shown in Table 2.

Table 2. Summary of Proposed Evaluation Methods and KPIs

Pilot Project	Method	KPI
Heavy vehicle progression and access on the AusLink network	Method 1: travel time analysis from automatic number-plate recognition (ANPR) system	<ul style="list-style-type: none"> travel time of all vehicles travel time of heavy vehicles
	Method 2: floating car survey following heavy vehicles at peak periods	<ul style="list-style-type: none"> travel time and stop times of heavy vehicles
	Method 3: instrumental measurement of vibration and noise	<ul style="list-style-type: none"> vibration noise levels
Road closure system for range crossing	Method 1: roadside driver survey after installation	<ul style="list-style-type: none"> driver comprehension perceived safety
	Method 2: crash data comparison (if data is available)	<ul style="list-style-type: none"> safety
Flood warning system	Method 1: user comprehension study after installation	<ul style="list-style-type: none"> driver comprehension and attitude effects on user's decision making process perceived safety
	Method 2: crash data comparison if data is available	<ul style="list-style-type: none"> safety
Network access system for western districts	Method 1: roadside driver survey after installation	<ul style="list-style-type: none"> driver comprehension and attitude effects on user's decision making process perceptions of efficiency changes before and after installation

4.5 National Road Network – Pavement Rehabilitation Needs

The purpose of this project was to determine future investment needs for the maintenance and rehabilitation of the Queensland National Road Network. The study was part of a broader strategic review of pavement rehabilitation and safety needs. The key objectives of this study were to:

- assess the current condition of the existing sealed and asphalt surfaced roads
- determine strategic needs and cost estimates, including backlogs, for different scenarios
- determine the geographical location of investment candidates
- present future performance scenarios in terms of key performance indicators.

The study drew on QDMR's extensive information on road characteristics, road works history, traffic and current maintenance costs. This was supplemented by structural surveys of the entire network, and a detailed review of road conditions and treatment needs on a representative sample of roads. The following future maintenance policy scenarios were defined:

- Current funding policy, comprising full programmed maintenance involving the application of age and distress triggered resurfacing treatments allowed by current funding levels. Excessive routine pavement maintenance costs were assigned on a section-by-section basis and costed in the analysis.
- Minimum standards policy, comprising a set of interventions which aimed to ensure that all pavements are subject to preventative maintenance, including application of age- and distress-triggered resurfacing treatments, and that no pavement operates in a very poor condition state with respect to ride quality.
- Moderate standards policy, where no pavement operates in a poor condition with respect to the AusLink ride quality index (RQI), and receives appropriate preventative maintenance and intermediate treatments to address surface distress, both cracking and rutting. Higher pavement maintenance costs were assigned to a number of sections in the period prior to major works.
- a number of options including:
 - economic policy, which compared the minimum standards policy with the moderate standards policy in an economic analysis, with the selection of treatment policy for each section based on economic considerations (maximisation of NPV)
 - maximise condition policy, which compared the minimum standards policy with the moderate standards policy, with the selection of treatment policy for each section based on maximising the change in ride quality.

Comparison across strategies was made possible by determining the total transport costs, comprising the sum of road agency costs and road user costs, associated with each strategy, and for the base scenario, namely the Current Funding Policy.

The net economic benefits of the alternative strategies (which all involved increases in funding) were found to be between \$2 and \$3 for every additional dollar spent. The implications of delaying implementation of the alternative strategies for, say, up to five years ahead or restricting new funding to the most important roads was also investigated. However, should this happen, a considerable backlog would develop, and treatment costs would be more expensive, and costs to users would rise.

A regional data report was prepared which contained a general description of the study and information for use at a regional level as an input to the process of selecting candidate treatment sections, including: a description of the detailed work program information and supporting section data for each 1 km road segment for a selected maintenance policy, the 'moderate standards' policy, a summary of the work program information by region and by corridor, and supporting appendices containing maps and listings of work program information for the first five-year period.

The work programs are based on a life cycle costing analysis of needs and employ a desirable set of engineering standards. The results are indicative only and will be subject to field review and verification, although it is anticipated they will provide an input to program development. Recommendations were provided regarding the application of the data, including the need to give priority to essential routine maintenance, to preserve road assets through appropriate programmed maintenance and prioritise rehabilitation works using an appropriate indicator.

Further details are provided in a companion paper to this Conference [4].

5 CONCLUSIONS

In August 2007, ARRB signed a multi-million dollar agreement with QDMR to provide research expertise and knowledge sharing between the two organisations. The Agreement was the first of its type in Australia. A major aim of the Agreement is to secure in-house specialist capabilities in both organisations over the longer term.

The desired outcome of the Agreement is to improve the specialist capability and capacity of QDMR and ARRB through a sustained, collaborative program of challenging projects which deliver superior technology and road and transport solutions for the people of Queensland. The focus of the technical issues being addressed under the Agreement includes: road safety, pavements and materials, structures, traffic engineering including ITS, asset management, transport and traffic management, transport economics, project management and environmental management.

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